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by

Godfrey Boyle

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TEL: +44(0)1277 224632 · FAX: +44(0)1277 223453
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Offshore Wind: the Potential to Contribute a Quarter of UK Electricity by 2024

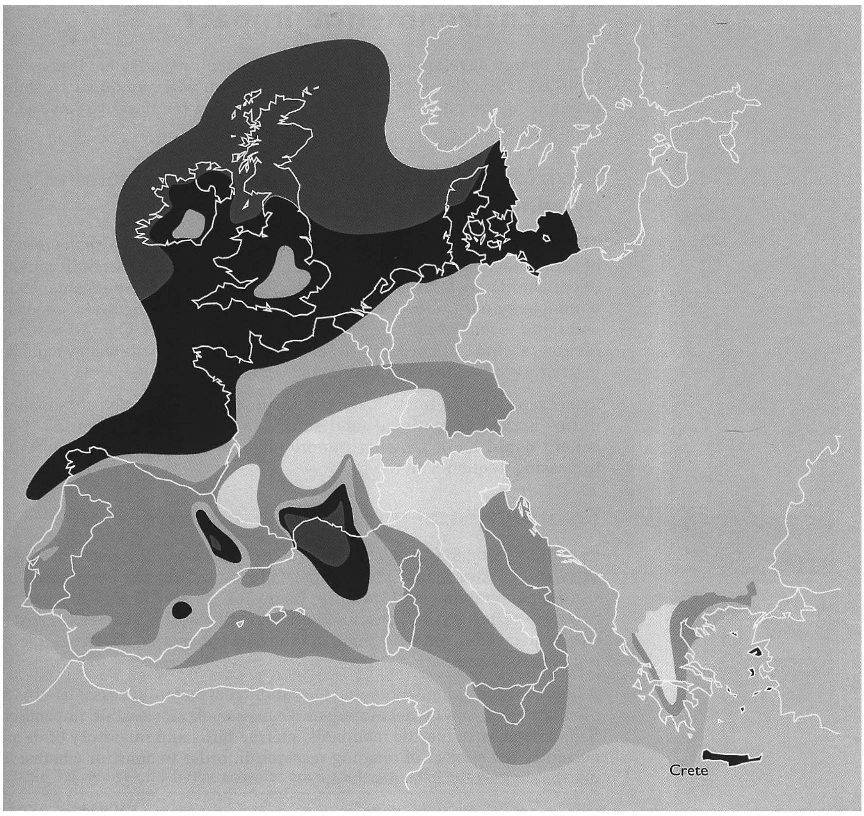
Godfrey Boyle
Director, Energy and Environment Research Unit, The Open University, UK
Email < G.A.Boyle@open.ac.uk >

ABSTRACT
The United Kingdom has very significant wind energy resources. In particular, the winds offshore could supply a major proportion of the nation's electricity requirements. Yet current offshore wind construction projects are progressing slowly. Over the next two decades, it is argued that Britain should adopt a much more ambitious programme to install many thousands of megawatts of offshore generating capacity by means of a public-private partnership, following the successful example of the offshore oil and gas industries of the 1970s and 1980s. By 2024, offshore wind could be contributing some 25% of UK electricity.

1. INTRODUCTION
The geographical position of the United Kingdom to the north east of the North Atlantic gives it a very significant wind resource (Figure 1), as demonstrated by several major resource studies (for example, DTI, 1998; Chapman and Gross, 2002). *Onshore* wind power has been the main thrust of development to date, with approximately 2000 MW of capacity (in c.135 wind farms) installed by March 2007 (BWEA, 2007 and Cameron, 2007). Progress has been slow, however, mainly due to significant local objections arising at the planning permission stage. Hence there is significant interest in and commitment to *offshore* wind power, where there is a single owner of the seabed (the Crown Commissioners, acting for the UK government) and few (or no) nearby inhabitants. Table 1 gives an outline of the status of offshore wind power development around the UK.

2. OFFSHORE WIND FARM DEVELOPMENT
2.1 Offshore Plans: Rounds 1 and 2
Four UK offshore wind farms (at North Hoyle, Kentish Flats, Scroby Sands and Barrow, with a total capacity of c.300 MW) were installed by early 2007. During the few years after this, the DTI's initial Round One offshore plans envisage an expansion to around 1000 MW (see Figure 2a and Table 2a).

The DTI's 'Round Two' offshore wind plans are more ambitious, involving some 15 additional offshore wind farms, some of them of over 1000 MW in capacity, building up to a total capacity of some 7.2 GW. The timescale for this is still uncertain (see Figure 2b and Table 2b).



Wind resources at 50 m above ground level for five different topographic conditions										
	Sheltered terrain		Open plain		At a sea coast		Open sea		Hills and ridges	
	m s^{-1}	W m^{-2}	m s^{-1}	W m^{-2}	m s^{-1}	W m^{-2}	m s^{-1}	W m^{-2}	m s^{-1}	W m^{-2}
	>6.0	>250	>7.5	>500	>8.5	>700	>9.0	>800	>11.5	>1800
	5.0–6.0	150–250	6.5–7.5	300–500	7.0–8.5	400–700	8.0–9.0	600–800	10.0–11.5	1200–1800
	4.5–5.0	100–150	5.5–6.5	200–300	6.0–7.0	250–400	7.0–8.0	400–600	8.5–10.0	700–1200
	3.5–4.5	50–100	4.5–5.5	100–200	5.0–6.0	150–250	5.5–7.0	200–400	7.0–8.5	400–700
	<3.5	<50	<4.5	<100	<5.0	<150	<5.5	<200	<7.0	<400

Figure 1. Annual Mean Wind Speeds and Wind Energy Resources over Europe (EU 15 countries) (Source: adapted from Troen and Petersen, 1989)

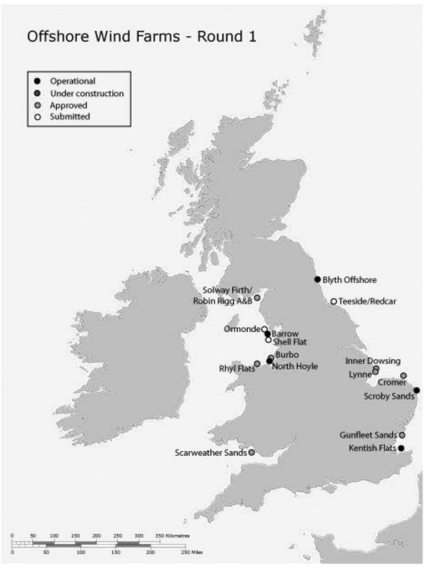


Figure 2a. Sites for UK Round 1 Offshore Wind Projects

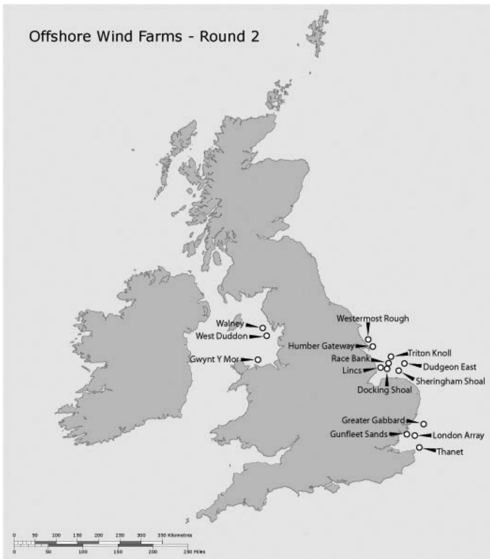


Figure 2b. Proposed sites for UK Round 2 Offshore Wind Projects

Table 1. Status (March 2007) of UK Offshore Wind Generating Capacity

Source, BWEA (http://www.bwea.com/ukwed/offshore.asp) accessed April 13th 2007

Wind farm	Location	Region	Turbines	Power	MW	Status	Developer
Barrow	7 km from Walney Island	North West	30	3	90	Operational	Barrow Offshore Wind Ltd
Beatrice	Beatrice Oilfield, Moray Firth	Scotland	2	5	10	Under construction	Scottish & Southern
Blyth Offshore	1 km from Blyth Harbour	North East	2	2	3.8	Operational	AMEC Wind
Burbo	5.2 km from Crosby	North West	25	3.6	90	Under construction	SeaScape Energy
Cirrus Array (Shell Flats)	7 km from Cleveleys	North West	90	0	270	Submitted (S36)	CeltPower Ltd/ Elsam A/S/ Shell Wind Energy Aegir Ltd
Cromer	7 km from Cromer	East of England	30	4	108	Withdrawn after approval	NOW (Norfolk Offshore Wind)
Greater Gabbard		Thames Estuary	0	0	500	Approved	Airtricity
Gunfleet Sands (september) TWA	7 km from Clacton-on-Sea	East of England	30	3.6	108	Approved	GE Wind
Gwynt y Mor	Liverpool Bay (13-15 km offshore)	North West	0	0	750	Submitted (S36)	npower renewables
Inner Dowsing	5.2 km from Ingoldmells	East Midlands	30	3	97	Under construction	Centrica Renewable Energy Ltd
Kentish Flats	8.5 km offshore from Whitstable	South East	30	3	90	Operational	GREP UK Marine Ltd
Lincs		Greater Wash	0	0	250	Submitted (TWA)	
London Array		Thames Estuary	270	0	1000	Approved	London Array Ltd
Lynn	5.2 km from Skegness	East Midlands	30	3	97	Under construction	Centrica Renewable Energy Ltd
North Hoyle	7.5 km from Prestatyn & Rhyl	North Wales	30	2	60	Operational	NWP Offshore Ltd
Ormonde	off Walney Island	North West	30	3.6	108	Approved	Eclipse Energy
Rhyl Flats	8km from Abergele	North Wales	30	0	90	Approved	NWP Offshore Ltd
Scarweather Sands	5.5 km from Sker Point (nr Porthcawl)	South Wales	30	3.3	90	Approved	E.ON UK Renewables
Scroby Sands	3 km from NE Great Yarmouth	East of England	30	2	60	Operational	E.ON UK Renewables
Sheringham Shoal	Sheringham, Greater Wash	East of England	0	0	315	Submitted (S36)	Scira Offshore Energy Ltd
Solway Firth/ Robin Rigg A	9.5 km from Maryport/ 8.5km off Rock Cliffe	Scotland	30	3	90	Under construction	E.ON UK Renewables
Solway Firth/ Robin Rigg B	9.5 km from Maryport/ 8.5km off Rock Cliffe	Scotland	30	3	90	Under construction	E.ON UK Renewables
Teeside/Redcar	1.5 km from NE Teesmouth	Yorkshire & Humber	30	0	90	Submitted (TWA)	NOW (Northern Offshore Wind Ltd)
Thanet		Thames Estuary	0	0	300	Approved	Warwick Energy
Walney		North West	0	0	450	Submitted (S36)	DONG
West Duddon		North West	0	0	500	Submitted (S36)	Scottish Power

Table 2a. Locations, Status, Capacity and Developers of UK Round One Offshore Wind Projects (to March 2007)

Location	Status	Capacity	Developer/Turbines
North Hoyle	Operating (Dec 2003)	60 MW	npower renewables (Vestas 2 MW)
Scroby Sands	Operating (Dec 2004)	60 MW	E.ON UK Renewables (Vestas 2 MW)
Kentish Flats	Operating (Sep 2005)	90 MW	Elsam (Vestas 3 MW)
Barrow	Operating (Sept 2006)	90 MW	Centrica/DONG (Vestas 3 MW)
Gunfleet Sands	Approved	30 turbines	GE Energy
Lynn/Inner Dowsing	Approved	60 turbines	Centrica
Cromer	Approved	30 turbines	Norfolk Offshore Wind/EDF
Scarweather Sands	Approved	30 turbines	E.ON UK Renewables/Energi E2
Rhyl Flats	Approved	30 turbines	npower renewables
Burbo Bank	Approved	30 turbines	Seascape Energy
Solway Firth	Approved	60 turbines	E.ON UK Renewables
Shell Flat	Submitted	90 turbines	ScottishPower/Tomen/Shell/Elsam
Teesside	Submitted	30 turbines	Northern Offshore Wind/EDF
Tunes Plateau *	Submitted	30 turbines	RES/B9 Energy
Ormonde *	Submitted	30 turbines	Eclipse Energy

* These two projects were outside the original Round 1 process but conform to its terms; Ormonde is an innovative wind-gas hybrid project

Table 2b. Locations, Status, Capacity and Developers of UK Round Two Offshore Wind Projects (to March 2007)

Location	Maximum capacity (MW)	Developer
Docking Shoal	500	Centrica
Race Bank	500	Centrica
Sheringham	315	Ecoventures/Hydro/SLP
Humber	300	Humber Wind
Triton Knoll	1,200	npower renewables
Lincs	250	Centrica
Westermost Rough	240	Total
Dudgeon East	300	Warwick Energy
Greater Gabbard	500	Airtricity/Fluor
Gunfleet Sands II	64	GE Energy
London Array	1,000	Energi E2-Farm Energy/Shell/ E.ON UK Renewables
Thanet	300	Warwick Energy
Walney	450	DONG
Gwynt y Mor	750	npower renewables
West Duddon	500	ScottishPower
TOTAL	**7,169**	

A report in 2006 by the British Wind Energy Association (BWEA), *Offshore Wind: at a Crossroads* (BWEA, 2006), demonstrated convincingly that, with moderate additional 'pump-priming' support over the following decade, installed offshore wind capacity could be c.8 GW by 2015, supplying some 6% of UK electricity. However, the report identified a number of problems that have slowed progress. These included substantial increases in wind turbine prices due to greatly increased world demand, higher costs due to inadequate reliability of current turbines (mostly designed for onshore use) in an offshore environment, higher world prices of raw materials, and uncertainty regarding grid connection costs. Further deterrents to offshore development include the long-term uncertainty in the value of Renewable

Obligation Certificates[1] beyond 2015, and the possibility that other renewable energy options may become more attractive investments than offshore wind.

The BWEA concluded, following extensive consultation with developers, that there is "an economics gap of up to around 25% of installed project cost." The additional support required could take the form either of capital grants of around £0.3 million per MW of installed capacity, or of enhanced price support for offshore wind under the Renewables Obligation (RO). One way of achieving the latter, suggested by the Scottish Executive, would be to assist offshore wind and other marine renewables by offering them double Renewable Obligation Certificates for each MWh of electricity generated.

Without such support, the BWEA concluded that UK offshore wind capacity would probably grow very slowly, to only around 2 GW by 2015. This rate of deployment would not be sufficient to give suppliers, contractors and utilities the necessary confidence to make the major investments required to achieve economies of scale and long-term cost reductions. Present Government targets for renewables electricity require a greater rate of installation of capacity.

2.2 Further Major Offshore Expansion: Round Three and Beyond

The BWEA's "New Policy Impetus" Scenario, as mentioned above, envisages offshore capacity growing, with additional support, to some 8 GW by 2015. By then, Rounds One and Two would be completed and an additional Round Three of construction would have started. Installed capacity should consequently increase to around 10.5 GW by 2017, with annual growth rates increasing to around 1.2 GW per annum by early in the next decade.

However, it is technically feasible for growth rates to be faster than this, and for the expansion to continue beyond 2015-2017.

The Scenario illustrated in Table 3, although similar to the BWEA's in its first decade, is more optimistic. The number of turbines installed per year builds up from 90 in 2006 to 400 in 2015. The capacity of each turbine installed also increases gradually, in line with the steady growth in turbine sizes seen in recent years, from the present 3 MW per turbine to 5 MW by 2012. Five-megawatt machines have already been demonstrated by several European manufacturers, and two 5 MW prototypes are being installed in 2007 at the Beatrice offshore wind site in Scotland (see Table 1). The BWEA scenario also envisages such turbines coming into use early in the next decade. (Even-larger offshore turbine sizes are considered likely by many experts, but are not considered in this scenario). Annual capacity factors for the offshore wind farms in the scenario are projected to rise slightly as technology and operational experience is gained, from 0.36 (the capacity factor achieved in the UK's first offshore wind farm, North Hoyle, in its first full year of operation) in 2006 to 0.38 by 2024.

The scenario in Table 3 envisages the annual installation rate increasing to 2 GW per annum by 2015 (equivalent to four hundred 5 MW turbines per year) and continuing at that rate until 2024. A deployment rate of 2 GW per annum is not unrealistic: it is the average rate at which wind turbines (each averaging only 1 MW capacity) have been installed in Germany in recent years (Deutsche Energie-Agentur, 2006); and it is slightly less than the rate of installation in the USA in 2005, which was 2.4 GW/y. By 2015, the scenario envisages the total installed capacity to be about 10 GW, compared to 8 GW in the BWEA scenario. By 2024, it shows further strong growth in offshore capacity, to a total installed capacity of some 28 GW.

[1]In the UK, as well as trading in actual exported electricity, generators of renewables electricity are awarded Renewable Obligation Certificates (ROCs) which can then be traded separately to Suppliers. The present value of a ROC is now about £45 (Euro 72) per MWh, whereas the value of the actual exported electricity is about £30 (Euro 48) per MWh.

The programme envisaged would involve the installation in 18 years of around 6,000 offshore turbines, ranging in size from the current 3 MW to the 5 MW size expected after 2012. Notionally, these could be located in, say, 30 arrays of 200 turbines each. There is no shortage of space for such arrays in the UK's extensive surrounding seas, allowing room for shipping lanes, fishing, defence radar exclusion zones and other uses.

2.3 Contribution to Electricity Supplies & Carbon Savings

By 2024, the projected 28 GW of offshore wind generating capacity would be producing some 94 TWh annually, just over 26% of current annual UK electricity demand, and saving some 5.7% of the nation's current total annual carbon emissions from all fossil fuel sources.

Table 3. Proposed Major UK Offshore Wind Power Programme: Timing, Capacity, Output, % of Electricity, Carbon (C) Savings

Year	Turbine Size (MW)	Turbines per year	Total No. Turbines	Capacity Added (GW/y)	Total Wind Capacity (GW)	Capacity Factor	Annual Output (TWh)	Percent of UK Elec Demand	Annual C Savings (MtC)	Percent of UK C Emissions
NOTES	1	2			5	6		7	3	4
2006	2.5	90	90	0.2	0.2	0.36	0.7	0.2%	0.1	0.0%
2007	2.9	120	210	0.3	0.6	0.36	1.8	0.5%	0.2	0.1%
2008	3.3	150	360	0.5	1.1	0.36	3.4	0.9%	0.3	0.2%
2009	3.7	180	540	0.7	1.7	0.36	5.5	1.5%	0.5	0.3%
2010	4.2	210	750	0.9	2.6	0.36	8.3	2.3%	0.8	0.5%
2011	4.6	240	990	1.1	3.7	0.37	12.1	3.4%	1.2	0.7%
2012	5.0	270	1260	1.3	5.1	0.37	16.4	4.6%	1.6	1.0%
2013	5.0	300	1560	1.5	6.6	0.37	21.3	5.9%	2.1	1.3%
2014	5.0	350	1910	1.7	8.3	0.37	27.0	7.5%	2.6	1.6%
2015	5.0	400	2310	2.0	10.3	0.37	33.4	9.3%	3.2	2.0%
2016	5.0	400	2710	2.0	12.3	0.38	41.0	11.4%	4.0	2.5%
2017	5.0	400	3110	2.0	14.3	0.30	37.6	10.4%	3.6	2.3%
2018	5.0	400	3510	2.0	16.3	0.37	52.9	14.7%	5.1	3.2%
2019	5.0	400	3910	2.0	18.3	0.37	59.4	16.5%	5.8	3.6%
2020	5.0	400	4310	2.0	20.3	0.38	67.6	18.8%	6.6	4.1%
2021	5.0	400	4710	2.0	22.3	0.38	74.3	20.6%	7.2	4.5%
2022	5.0	400	5110	2.0	24.3	0.38	80.9	22.5%	7.8	4.9%
2023	5.0	400	5510	2.0	26.3	0.38	87.6	24.3%	8.5	5.3%
2024	5.0	400	5910	2.0	28.3	0.38	94.2	26.2%	9.1	5.7%

NOTES
1. Average capacity of turbines installed in given year; increases from 2.5 MW to 5 MW by 2012
3: Based on offsetting C emissions from CCGT @ 97tC/GWh = 0.097MtC/TW
4. Current Total UK C emissions: c.160 MtC per year
5. Excludes ON-shore wind capacity: currently c. 1GW
6. Assumes gradual increase in offshore Capacity Factor (CF) from current 0.36 to 0.38 by 2024 (conservative)
7. Current UK Elec demand: c. 360 TWh

2.4 Wind Variability: a Minor Cost

The offshore wind power scenario outlined in Table 3, would contribute about 94 TWh per annum, c.26% of current UK electricity demand. In addition to this, the UK total installed capacity of on-shore wind farms is likely to increase from the present value of 1 GW, to as much as 10 GW by 2024. Assuming a smaller on-shore capacity factor of 0.3, this would produce some 26 TWh annually. Added to the estimated 94 TWh produced by the proposed offshore programme, the total electricity output from UK wind power would be about 120 TWh/y. This would amount to about one third of current UK electricity requirements.

The UK Energy Research Centre's study of the additional reserve costs associated with the variability of renewable energy sources, published in April 2006, makes it clear that, contrary to many popular misconceptions, such costs of necessary reserve capacity are relatively modest. For a 20% contribution of wind energy to the grid, the additional cost of having and using reserve power is around 0.3p/kWh; and for a wind energy contribution of up to 45% (somewhat less than that envisaged here), the additional costs are unlikely to exceed 0.5p/kWh (UKERC, 2006). Note that all forms of power generation need reserve capacity, not just renewables.

3. THE SCALE AND IMPACT OF A MAJOR DEVELOPMENT IN WIND POWER

3.1 Comparison of wind power with a Major UK Nuclear Programme

Table 4 shows a scenario by this author for the progression of a major nuclear power expansion programme in the UK over the next two decades. The scenario assumes a go-ahead by Government in principle in 2007, and three years for Parliamentary approval, licensing, planning permission etc. Construction of the first Pressurised Water Reactor (PWR) might commence in 2010 and take five years. Ten stations of the Westinghouse AP1000 type are envisaged in the scenario, each with a generating capacity of 1.1 GW, and built at a rate of one per year. The annual average capacity factor of the installed nuclear power plant is projected to rise from 75% in 2015 to 85% by 2024. By that date, the 11 GW programme could be complete and generating some 82 TWh of electricity per year, about 23% of current demand. In

Table 4. Major UK Nuclear Expansion Programme, 2006-2024: Output; % of UK Elec & C Emissions.

Year	Plant Capacity (GW)	No. of new plants per year	Capacity Added (GW/y)	Cumulative Capacity (GW)	Capacity Factor	Annual Output (TWh)	Percent of Elec Demand	Annual C Savings (MTC)	Percent of UK C Emissions
NOTES	1				2		7	3	4
2007	start planning								
2008	planning								
2009	construction								
2010	0	0	0	0		0	0	0	0
2011	0	0	0	0		0	0	0	0
2012	0	0	0	0		0	0	0	0
2013	0	0	0	0		0	0	0	0
2014	0	0	0	0		0	0	0	0
2015	1.1	1	1.1	1.1	0.75	7.2	2.0%	0.7	0.4%
2016	1.1	1	1.1	2.2	0.76	14.6	4.1%	1.4	0.9%
2017	1.1	1	1.1	3.3	0.77	22.3	6.2%	2.2	1.3%
2018	1.1	1	1.1	4.4	0.79	30.4	8.5%	3.0	1.8%
2019	1.1	1	1.1	5.5	0.80	38.5	10.7%	3.7	2.3%
2020	1.1	1	1.1	6.6	0.81	46.8	13.0%	4.5	2.8%
2021	1.1	1	1.1	7.7	0.82	55.3	15.4%	5.4	3.4%
2022	1.1	1	1.1	8.8	0.83	64.0	17.8%	6.2	3.9%
2023	1.1	1	1.1	9.9	0.84	72.8	20.2%	7.1	4.4%
2024	1.1	1	1.1	11	0.85	81.9	22.8%	7.9	5.0%

NOTES
1. Assumes 3 years from 2007 for permissions; start 1st reactor in 2010; 5 years to first generation; 1 Westinghouse AP1000/yr for 10 yrs
2. Assume mean CF increases gradually from 0.75 to 0.85
3: Based on offsetting C emissions from CCGT @ 97tC/GWh = 0.097MTC/TWh
4. Current Total UK C emissions: c.160 MTC
5. Current UK Elec demand: c. 360 TWh

comparison with the main alternative fossil-fuelled electricity generation option, i.e. a number of combined cycle gas turbine (CCGT) power stations, this would lead to a saving of about 5% of the UK's current annual carbon emissions. In comparison with the same quantity of electricity generated from wind power, there would be an increase in global carbon emissions due to the need to mine and process the nuclear fuel.

3.2 Monetary Costs: Wind versus Nuclear

The Cabinet Office's Performance and Innovation Unit (now the Prime Minister's Strategy Unit) in its 2002 *Energy Review* estimated that by 2020 the generating cost of electricity from offshore wind would be some 2.0-3p/kWh, compared to that of new nuclear plant at 3-4 p/kWh (Chapman and Gross, 2002). These costs are in constant 2002 prices and take into account, for both wind and nuclear, repayment of capital costs, interest on capital, fuel costs, and operation and maintenance costs. They also take into account the cost reductions achievable through large-scale series production, as each technology progresses down the 'learning curve'.

The UK Energy Research Centre's intermittency study, (reference, as quoted above), would suggest that some 0.5 p/kWh should be added to the generating costs of the major offshore wind programme proposed here, in order to allow for the cost of additional reserve power. This would increase the costs of offshore wind power to around 2.5-3.5 p/kWh. This is still somewhat lower than the PIU estimate of 2020 nuclear generating costs, at 3.0-4.0 p/kWh. (The PIU cost estimates do not include the cost of grid strengthening or of additional reserve capacity, but this would be required for new, large-scale generating programmes, whether wind or nuclear). However the estimates are very close and the uncertainties inherent in such projections would suggest that the actual generating costs in the mid- 2020s of offshore wind and nuclear power would probably be very similar.

3.3 Employment

Some 50,000 people are currently employed in the German wind energy industry, supporting an installation rate of around 2 GW per annum (Deutsche Energie-Agentur, 2006). The similar installation rate proposed here for the UK should generate a similar number of jobs. The UK does not have any major wind turbine manufacturer, but is established in blade and other component manufacture. If a major offshore wind programme were implemented, UK-based manufacturing would probably revive; or employment-creating joint ventures between UK and other EU firms, such as that between Germany's REpower and the UK's Peter Brotherhood, could be established. The UK has considerable experience in offshore engineering and support because of its North Sea oil and gas operations; much of that experience and associated investment would transfer to offshore wind power. In any case, apart from turbine manufacture, there would be many thousands of jobs in assembly, delivery, installation, connection and servicing of offshore wind farms. The creation of such an industry would ensure continuing employment in the UK offshore sector, as reserves of oil and natural gas decline.

3.4 Facilitating Offshore Wind Power Through Public-Private Partnerships

Government could greatly assist the offshore wind industry in moving beyond its current pioneering phase toward maturity, and eventually lower costs, by giving additional capital grant support to Round One and Round Two projects, or by allocating additional revenue support to offshore wind under the RO.

A further form of support could be through the creation of a public-private partnership to build the new electrical infrastructure required to connect offshore wind farms, and other marine technologies such as wave and tidal power, to the national grid.

This would, of course, involve additional public sector borrowing by the Treasury, but as the UK Chancellor of the Exchequer has repeatedly emphasised, public borrowing for investment is a sound and prudent use of taxpayers' money. The capital cost of offshore grid infrastructure could be raised by issuing Government-backed bonds. This expenditure would be repaid over the lifetime of the assets created, say 30-40 years, at the low interest rates at which Governments can borrow money, typically around 5-6%. Repayment could take the form of a levy on each unit of electricity sold by the offshore wind farm operators. The construction and operation of the offshore wind farms themselves would be left to the private sector, as at present.

As Edward O'Connor, managing director of the wind farm developer Airtricity, has pointed out, the suggestion that Government should fund basic grid infrastructure for long-term public benefit is hardly new:

"Henry Ford quite rightly refused to contribute to building the roads. He judged that society should pay for them.(...) It is quite appropriate that offshore grids should be paid for by the government. If you want a new technology you should not over-burden it with costs", (quoted in Massy, 2005)

Airtricity, which developed Ireland's first offshore wind farm at Arklow Bank and recently received approval to construct a 500 MW offshore wind farm at Greater Gabbard in the Thames Estuary (See Table 2b), has recently put forward an ambitious proposal to create an offshore 'Supergrid', initially linking very large offshore wind farms in the UK, Germany and Denmark. Eventually offshore wind farms in Southern Europe would also be connected. The Supergrid would not only facilitate the interchange of electrical power between EU member states, but would enable a more constant output of wind-generated electricity, due to the diversity of wind speeds in different European regions (Airtricity, 2006)

4. CONCLUSIONS

The UK's first offshore wind farms are up and running. With the right support from Government over the next two decades, they could be followed by many more.

By around 2024, a vigorous programme of offshore wind deployment could be delivering some 26% of UK electricity, thereby abating carbon emissions equal to nearly 6% of UK present total emissions, compared with c.23 % of electricity and c.5% equivalent carbon abatement from a programme of 10 nuclear power plants. With adequate initial support, the cost of electricity from offshore wind by 2020 is likely to reduce, through economies of scale, to approximately the same per unit of generation as that from nuclear power (or possibly slightly less) even allowing for the additional costs of reserve power to back-up wind variable supplies[2] . The proposed size, timescale and costs of the offshore wind programme proposed here may seem optimistic, but they are no more so than the size, timescale and costs of a comparable new nuclear programme. A further advantage of wind power is that installation can start immediately and proceed by modular increase, without the probable 10 year delay in completing the design, planning and construction of ˜ 1000 MW new nuclear plants.

[2]The assumption made here, to err on the side of pessimism towards wind, is that additional nuclear generation does not require additional backup capacity. However nuclear power, like all forms of generation, is subject to occasional intermittency and requires backup supplies

The challenges facing the 21st century UK offshore wind industry in the demanding marine environment may be substantial, but they are no more insuperable than those faced by the offshore oil and gas industry in the 1970s and 80s. By the early 2020s, given a mutually-beneficial partnership between Government and industry, Britain could boast a world-class offshore wind industry generating a quarter of the nation's electricity, supporting around 50,000 jobs, offsetting the decline in UK's offshore oil and gas industries, and with excellent export potential.

REFERENCES

Airtricity (2006) *European Offshore Supergrid Proposal,* Airtricity, Dublin, May, 24pp.

BWEA (2006) *Offshore Wind: at a Crossroads*, British Wind Energy Association, April, 16pp.

BWEA, 2007 (http://www.bwea.com/statistics/) British Wind Energy Association

Cameron, A. (2007) "On the Cusp? An Update on the State of the Offshore Wind Market", *Renewable Energy World,* Volume 10, No 2, March-April, pp 22-35.

Deutsche Energie-Agentur (Germany Energy Agency) website: http://www.renewables-made-in-germany.com/

DTI (1998) *Renewable Energy in the UK: Prospects for the 21st Century,* Department of Trade and Industry Report.

Massy, J. (2005) "Turbulent Waters Create Market Drag", *Windpower Monthly,* April, pp 45-52.

Chapman and Gross (2002) *The Energy Review, Annex 6: The Potential for Cost Reductions and Technological Progress in Low Carbon Technologies*, Table 1, page 5, and pp 189 - 199. Performance and Innovation Unit (now Prime Minister's Strategy Unit). UK Cabinet Office.

UKERC (2006) *The Costs and Impacts of Intermittency*, UK Energy Research Centre, London SW7 2PG, see in particular Section 3.3, Figure 3.2, pp 37-40.